A Preliminary Geotechnical Evaluation Report

Proposed Retail and Industrial Development
SW of Interstate Highway 35E & Main Street
Centerville, Minnesota

Prepared for

Bonestroo, Rosene, Anderlik & Associates

Professional Certification:
I hereby certify that this plan, specification or report was prepared by me or under my direct supervision and that I am a duly Registered Professional Engineer under the laws of the State of Minnesota.

CHARLES D. HUBBARD
LICENSED PROFESSIONAL ENGINEER
21153
STATE OF MINNESOTA

Charles D. Hubbard, PE, PG
Associate Principal/Senior Technical Consultant
License Number: 19943
December 15, 2005

Project SP-05-05003

Braun Intertec Corporation

BRAUN
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December 15, 2005

Project SP-05-05003

Mr. Thomas Peterson
Bonestroo, Rosene, Anderlik & Associates
2335 West Highway 36
Saint Paul, MN 55113

Re Preliminary Geotechnical Evaluation
Proposed Retail & Industrial Development
20th Avenue & Main Street
Centerville, Minnesota

Dear Mr. Peterson

We are pleased to present the attached preliminary geotechnical evaluation report for the above-referenced project. Our findings and recommendations are summarized below. More detailed information will be contained in the evaluation report to be issued at a later date.

Summary of Results

Each of the six borings initially encountered about one-half to two and one-half feet of topsoil. Below the topsoil, three of the borings encountered alluvial soils to depths of about 4 to 10 feet below existing grades. The alluvial soils predominantly consisted of lean clay, with lesser amounts of clayey sand. Below the topsoil and alluvial soils, the borings encountered and terminated in glacial soils. The glacial soils consisted primarily of sandy lean clay, with lesser amounts of lean clay, silty sand, and poorly graded sand with silt.

Penetration resistance values indicated that the alluvial soils were rather soft to rather stiff, but generally medium. Penetration resistance values indicated that the cohesive glacial soils ranged from soft to rather stiff, but were generally medium. Penetration resistance values indicated that the granular glacial soils were very loose to medium dense, but generally loose.

Groundwater was observed during drilling in each of the six borings at a depths ranging from one to four feet below existing grades. Given the variability in these measurements, it is difficult to ascertain where the static groundwater currently exists, however, it is clear that perched and trapped water exists at multiple and shallow elevations across this site.

Summary of Preliminary Recommendations

Building Support

The topsoil and surface vegetation are considered compressible and unsuitable for building support. These materials should be removed from beneath the proposed building pad areas. The alluvial and glacial soils encountered by the borings were typically soft to rather soft and overly wet. Those soils are considered marginally suitable for support of buildings. We therefore anticipate that soil corrections, consisting of the removal of soft soils and the replacement with compacted granular fill, will be necessary to achieve adequate bearing support.

In the absence of additional loading information, we anticipate that these corrections can be terminated at a depth of about equal to the width of the strip footings or one-half the width of isolated spread footings.

The on-site soils can be reused as engineered backfill in slab areas. However, those soils are typically significantly wet of their optimum moisture contents. If they are reused as structural backfill, it should be anticipated that significant drying would be required to obtain adequate compaction. The clayey soils are also moisture sensitive and subject to disturbance from construction traffic. Protecting these soils from disturbance and maintaining proper moisture contents during and after placement will be required during construction.

Pavement Support

The surface vegetation, root zones, topsoil and any existing fill are considered unsuitable for the direct support of pavements. The surface vegetation and root zone should be removed from beneath the pavement areas. It is our opinion that topsoil containing an organic content less than 7 percent can be left in place at depths more than 4 feet below top of pavement subgrades in heavy duty pavement areas and more than 3 feet below top of subgrades in light duty pavement areas. Non-organic existing fill and the naturally deposited alluvial and glacial soils are considered suitable for pavement support provided that they are stabilized prior to the placement of fill or pavement materials.

The long-term performance of the pavements would be enhanced by placing a sand cushion of about one to two feet over the alluvial or glacial soils to both provide support and help drain the commonly observed perched water. Drainage would also be enhanced by installing French drains along the curb line to relieve the aggregate base and subgrade of water trapped behind the curb.

Remarks

We appreciate the opportunity to be of service to you on this project. If you have questions about the attached report, please call us at 651.487.3245.

Sincerely,

BRAUN INTERTEC CORPORATION

Steven D. Gerber, PE
Senior Engineer

Charles D. Hubbard, PE, PG
Associate Principal/Senior Technical Consultant

Attachment:
Preliminary Geotechnical Evaluation Report

Table of Contents

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A. Introduction

A.1. Situation

This preliminary geotechnical evaluation report was prepared for Bonestroo, Rosene, Anderlik, & Associates Inc. (BRA), and concerns a proposed industrial park development, on behalf of the City of Centerville, to be located southwest of Interstate Highway 35E and Main Street, just east of 20th Street, in Centerville, Minnesota. The majority of this site is currently undeveloped, vegetated, and ponding water located at numerous locations across the site. A county drainage ditch also crosses the central portion of the site.

A.2. Project Goals

Our goals for this geotechnical evaluation included: (1) characterizing subsurface conditions across the site, (2) developing an opinion as to the suitability of the soils encountered for the proposed construction, and (3) discussing the extent of probable site work required for construction and for support of the proposed facilities.

A.3. Scope of Services

Our scope of services was performed under the terms of our General Conditions dated March 1, 2003, and was limited to:

- Coordinating the locating of underground utilities near the boring locations.
- Performing six penetration test borings to depths of about ten feet.
- Measuring groundwater levels, if present.
- Returning the samples to our laboratory for visual classification and logging by a geotechnical engineer.
- Conducting various laboratory tests on samples retrieved during drilling.
- Preparing this preliminary geotechnical report containing log of boring sheets, a summary of the results, an opinion as to the suitability of the soils encountered for support of the proposed facility and preliminary recommendations for general construction and sitework.

A.4. Boring Locations and Elevations

The approximate as-drilled boring locations are shown on Figure 1, which is a reproduction of a site plan provided to us by BRA. The boring elevations were estimated using the contours shown on the site plan.

B. Results

B.1. Log of Boring Sheets

The attached Log of Boring sheets classify and describe the materials encountered, and present the results of penetration resistance, laboratory tests and groundwater measurements. Geologic origins assigned to the strata shown on the logs were determined from a review of material classifications, penetration resistance tests, laboratory tests and geologic publications pertinent to the site and general area.

B.2. Materials Summary

The types of materials encountered by the borings are described below. The materials are generally described in the order they were encountered, i.e., beginning at the ground surface.

B.2.a. Topsoil

The borings each initially encountered topsoil to depths of about 1 to 2 ½ feet below existing grades. The topsoil typically consisted of organic clay that was black, contained traces of roots and was wet.

B.2.b. Alluvial Soils

Below the topsoil soils, three of the borings encountered alluvial soils to depths of about four feet to the termination depth of about 10 feet below existing grades. The alluvial soils predominantly consisted of lean clay, with lesser amounts of silty sand. The alluvial soils contained occasional layers of sand, were light brown, brown to black and were wet.

B.2.c. Glacial Soils

Below the topsoil and alluvial soils, the borings encountered and terminated in glacial soils. The glacial soils consisted primarily of glacial till, with lesser amounts of glacial outwash. The glacial till soils consisted of sandy lean clay, with lesser amounts of clayey sand and silty sand that were brown to gray, wet and contained varying amounts of gravel. The glacial outwash soils consisted of poorly graded sand with silt, silty sand and silt that were brown to gray, moist to waterbearing and contained varying amounts of gravel.

B.3. Penetration Resistance Data

Results of the penetration resistance tests performed in the materials encountered by the borings are summarized below in Table 1. Interpretive comments are provided to illustrate the engineering implications of the penetration resistances.

Table 1. Penetration Resistance Data Summary

Material	Classification	Range of Penetration Resistances	Comments
Alluvial Soils	CL (Lean Clay) and SC (Clayey Sand)	4 BPF to 11 BPF, with most values between 4 and 8 BPF.	Soft to rather stiff, but generally rather soft to medium.
Glacial Outwash	SP-SM (Poorly Graded Sand with Silt)	5, 7 and 10 BPF.	Generally loose.
Glacial Till	CL (Lean Clay) and SC (Clayey Sand)	4 BPF to 9 BPF, with an average of about 6 BPF.	Rather soft to rather stiff, but generally rather soft to medium.

B.4. Laboratory Test Results

Results of our laboratory tests are presented below in Table 2.

Table 2. Laboratory Test Results Summary

Boring Number	Sample Depth (ft)	Classification	Moisture Content (%)	Percent Passing a #200 Sieve	Organic Content (%)	Liquid Limit	Plastic Index
ST-2	Surface	Topsoil	90	–	15	105	79
ST-2	2 ½	Organic Clay	144	–	–	–	–
ST-3	Surface	Topsoil	16	–	2	–	–
ST-3	2 1/2	Silty Sand	28	41	–	–	–

B.5. Groundwater Measurements

Groundwater was observed in most of the borings at a depths ranging from about 1 to 4 feet below existing grades during drilling. Given the variability in depths that groundwater levels were observed, it appears that perched and trapped water exists at multiple and shallow elevations on this site.

Because most of the soils are fine-grained, and tend to release water slowly, a longer monitoring period (longer than what was available during our time on-site) would be required for water levels to stabilize in the boreholes. Consequently, groundwater levels may be higher than they were recorded, and water was observed at various locations on the site at the ground surface. Also, water levels will vary over time depending upon seasonal and climatic conditions.

C. Evaluation and Analyses

C.1. Design Details

C.1.a. Building Construction and Foundation Loading

We assume that the typical structures constructed on this site will consist of slab on grade buildings with relatively light structural loads, column loads of up to 150 kips and perimeter footings of about four to eight kips per lineal foot. We assume that the retail and industrial structures will have either masonry or precast concrete walls and steel structural components bearing on spread footings.

C.1.b. Pavement Types and Traffic Loads

We assume that the development will have both light and heavy-duty pavement areas. The pavements will consist of bituminous and/or concrete pavements

C.1.c. Anticipated Grade Changes

Based on Figure 1, we anticipate that fills of up to about five feet will be required to establish the Finish Floor Elevations shown in figure 1, above the existing grades. We anticipate that there will be limited amounts (plus or minus about two feet) of cuts and fill will be necessary to establish the pavement grades.

C.1.d. Precautions Regarding Changed Information

We have attempted to describe our understanding of the proposed construction to the extent it was reported to us by others. Depending on the extent of available information, assumptions may have been made based on our experience with similar projects. If we have not correctly recorded or interpreted the project details, we should be notified. New or changed information could require additional evaluation, analyses and/or recommendations.

C.2. Site Grading

The topsoil, surface vegetation, and existing fill materials (if any) are not considered suitable for support of footings, slabs and the direct support of pavements. Based upon the limited boring data, it appears that topsoil stripping of about 2 feet will be required for most of this site, although locally thicker deposits likely exist across the site, especially in low areas. It is our opinion that topsoil containing an organic content less than 7 percent may be left in place in pavement areas at depths more than 4 feet below the top of the subgrade in heavy duty pavement areas and at depths below 2 feet in light duty (parking) pavement areas provided that the surface vegetation and root zones are removed and the topsoil can be stabilized prior to placing fill.

The alluvial soils, in particular, and the glacial soils encountered by the borings were typically soft to rather soft and overly wet and are considered suitable for support of buildings only with soil corrections. At a minimum, after stripping the topsoil and surface vegetation, we recommend that soft clays and saturated, very loose sands should be removed from the building and pavement areas. The resulting excavation bottoms should then be scarified, blended and compacted prior to placement of backfill or additional required fill. All excavations should be adequately oversized by extending them at least one foot horizontal for each foot vertical below the bottom of footings or pavements.

The glacial soils, while locally weak, are typically less compressible than alluvial soils, and, as such, would make a more suitable base for support of the buildings and pavements. Consequently, consideration should be given to excavating down to the glacial soils and replacing the topsoil and alluvium with compacted backfill. The long-term performance of proposed structures and slabs would be further enhanced by using granular fill (less than 20 percent passing a number 200 sieve) as backfill and fill to provide both stronger subgrade soils and to facilitate drainage.

Most of the near surface clays are wet and relatively soft, as reflected in the shallow groundwater surface and visible surface ponding. It is our opinion that some correction of the soils may be required during mass grading. The clayey soils are also moisture sensitive and subject to disturbance from construction traffic. Protecting these soils from disturbance and maintaining proper moisture contents during and after placement will be required during construction.

C.3. Building Support

C.3.a. Slab Support

After removing the topsoil, existing fill and any soft, wet clayey soils and grading the site to proposed subgrade elevations, we assume that naturally deposited or compacted clayey soils will comprise the subgrade of the proposed buildings. From the soil boring data, it appears that the near surface clays are generally wet and could require subexcavations if footings or floor slabs bear directly on them. To provide adequate support for the building and reduce differential settlements, soft soils will need to be subexcavated from beneath footings and replaced with materials that can be adequately compacted.

To provide a stable subgrade and to assist in the support of the slabs, we recommend that the slab subgrade be stabilized. Clayey soils are highly susceptible to disturbance and loss of strength from construction activities. To facilitate construction and minimize delays and costs, it will be important to protect the subgrade soils during construction. One method would be to place a clear stone (such as 2-inch minus) or an aggregate base stone in the building pad to use as a working surface during construction.

Another alternative for stabilizing the slab subgrade would be to incorporate lime into the top 1 to 2 feet of the subgrade soils. The incorporation of lime would reduce the moisture contents of the subgrade soils and provide increased stability. The depth of stabilization would have to be evaluated during construction to determine if the subgrade soils have been stabilized enough to pass a proof roll.

Consideration can also be given removing the clayey soils to a depth of one to two feet, scarifying, blending, and compacting the base and placing a sand cushion consisting of coarse sand (less than 50% passing a number 40 sieve and 5% passing a number 200 sieve) below the finish subgrade elevation. This sand cushion would help provide a stable base during construction and long-term support of slabs, and it could be incorporated as part of drainage and sump pump system to help remove infiltrated water.

A separation geotextile could also be placed between the sand and the clayey subgrade to both help facilitate compaction and maintain the integrity of the sand cushion during construction. A vapor barrier or retarder should not be used to separate the subgrade from the sand cushion, although it would likely be desirable to place one directly beneath the slab to help prevent vapor transmission.

C.3.b. Foundation Support

At a minimum, all footing subgrades should be observed by a geotechnical engineer prior to the placement of backfill, additionally required fill, or concrete, to evaluate the need for additional soil corrections. The soil corrections would likely consist of removing weak or unsuitable soils and replacing them with compacted backfill, although the extent of these corrections could likely be limited to a depth equal to the width of perimeter footings or one-half the width of isolated spread footings.

Because the subgrade soils are rather variable and overall of marginal quality, it is our opinion that soil corrections will be necessary for most of the footings, unless they are all removed during site grading. Consideration can be given to anticipating this need and making provisions for a sand cushion beneath all footing subgrades.

For the anticipated structural loads, we estimate that spread footing foundations designed to exert bearing pressures between about 2,000 to 3,000 psf will likely be possible, depending upon the site grading and soil corrections, with settlements of less than 1 inch.

C.4. Pavement Support

After stripping the surface vegetation, root zones and topsoil and placing any fill required to reach proposed subgrade elevations, we anticipate that pavement subgrades will generally consist of clayey soils. Being more capable of tolerating settlements, it is our opinion that support for the pavements can be adequately achieved by the onsite soils.

Areas of soft and wet clays should be anticipated during subgrade preparations. Those soils would either need to be scarified, moisture conditioned to near optimum and recompacted, removed and replaced with soils that can be adequately compacted or the clays can be chemically stabilized with the use of lime or flyash. In general, the upper two to three feet of light duty pavements and three to four feet for heavy-duty sections will require these corrections.

Given the anticipated clayey subgrade soils, we anticipate that pavement sections on this site will likely need to be thicker than typical sections. To enhance the performance of the pavements, consideration should be given to placing a sand cushion of about one to two feet under the pavements. The sand cushion would help reduce the amount of required aggregate base and pavements required as well as help provide drainage and reduce the effects of frost heave, as the on-site soils are generally wet, drain poorly, and are highly susceptible to frost. To further help facilitate drainage, consideration can be given to placing draintile along the shoulder of the road and connecting the drain tile to the storm water drain or direct to a detention pond, or to provide drainage ditches along the side of the road. Further consideration can be given to placing a separation geotextile between the sand cushion and the subgrade to help maintain the integrity of the sand cushion and aggregate base from frost action of the subgrade and dynamic loading of the traffic, and, thereby enhancing the long-term performance of the pavement.

C.5. Utility Support

We anticipate that site utilities such as storm sewer, sanitary sewer and watermain will be placed at depths ranging from about 4 to 15 feet below finished grades. At those depths, the utilities will likely encounter alluvial, glacial till and glacial outwash soils. In our opinion, those soils will generally provide adequate support for the utilities. Some of the glacial soils were wet to waterbearing and will likely require subexcavations where wet clays exist and dewatering where waterbearing sands exist.

C.6. Reusing On-Site Materials

The topsoil encountered is not considered suitable for reuse as structural fill and backfill. Stripped topsoil should be placed in landscaped or ponding areas or hauled off-site.

The alluvial and glacial lean clay soils are considered suitable for reuse as structural backfill. However, the clayey soils are moisture sensitive and difficult to compact if overly wet (which they currently are) or if they become overly wet. For much of the clays on this site, some form of stabilization, either disking and drying or chemically stabilizing, will likely be required to obtain adequate compaction.

The glacial sands are considered suitable for reuse as structural backfill. However, many of the glacial sands were wet to waterbearing and will likely require drying to obtain adequate compaction.

C.7. Groundwater Considerations

As addressed in Section B.5, it appears that the groundwater was encountered at approximate depths between about two and four feet below existing grades. It is likely that perched and trapped conditions will be encountered during construction. However, it is our opinion that sumps and pumps will likely be adequate to remove water from excavations in the clayey soils encountered near the surface. Although, piezometers could be installed to better determine if the groundwater is the hydrostatic groundwater or perched and trapped groundwater. Excavations that penetrate the hydrostatic groundwater surface by more than about two feet would likely require the use of dewatering wells or points ahead of the excavation to control the groundwater.

D. Procedures

D.1. Exploratory Borings

D.1.a. Penetration Test Borings

The penetration test borings were drilled with an all terrain equipped with hollow-stem auger. The borings were performed in accordance with ASTM Test Method D 1586. Penetration test samples were taken at 2 ½- or 5-foot intervals. Actual sample intervals and corresponding depths are shown on the boring logs.

D.2. Materials Classification and Testing

Materials encountered in the borings were visually and manually classified in accordance with ASTM Test Method D 2488. A chart explaining the classification system is attached. Samples were sealed in jars or bags and returned to our facility for review and storage.

D.3. Groundwater Measurements

The drillers checked for groundwater as the borings were advanced, and again after auger withdrawal. The boreholes were then backfilled or allowed to remain open for an extended period of observation as noted on the boring logs.

Water levels in the flight auger borings were inferred from moisture contents apparent in the auger cuttings as they were withdrawn from the advancing boreholes. The drillers checked for groundwater again after auger withdrawal, and then the boreholes were immediately backfilled or allowed to remain open for extended observation.

E. Qualifications

E.1. Variations in Subsurface Conditions

E.1.a. Material Strata

Our evaluation, analyses and recommendations were developed from a limited amount of site and subsurface information. It is not standard engineering practice to retrieve material samples from borings continuously with depth, and therefore strata boundaries and thicknesses must be inferred to some extent. Strata boundaries may also be gradual transitions, and can be expected to vary in depth, elevation and thickness away from the boring locations. Although strata boundaries can be determined more accurately from visual examination of test pit sidewalls, the boundaries apparent at the test pit locations likely vary away from the test pits.

Variations in subsurface conditions present among borings or test pits may not be revealed until additional exploration work is completed, or construction commences. If any such variations are revealed, our recommendations should be re-evaluated. Such variations could increase construction costs, and a contingency should be provided to accommodate them.

E.1.b. Groundwater Levels

Groundwater measurements were made under the conditions reported herein and shown on the boring logs, and interpreted in the text of this report. It should be noted that the observation period was relatively short, and groundwater can be expected to fluctuate in response to rainfall, flooding, irrigation, seasonal freezing and thawing, surface drainage modifications and other seasonal and annual factors.

E.2. Continuity of Professional Responsibility

E.2.a. Plan Review

This report is based on a limited amount of information, and a number of assumptions were necessary to help us develop our recommendations. It is recommended that our firm review the geotechnical aspects of the designs and specifications, and evaluate whether the design is as expected, if any design changes sign have affected the validity of our recommendations, and if our recommendations have been correctly interpreted and implemented in the designs and specifications.

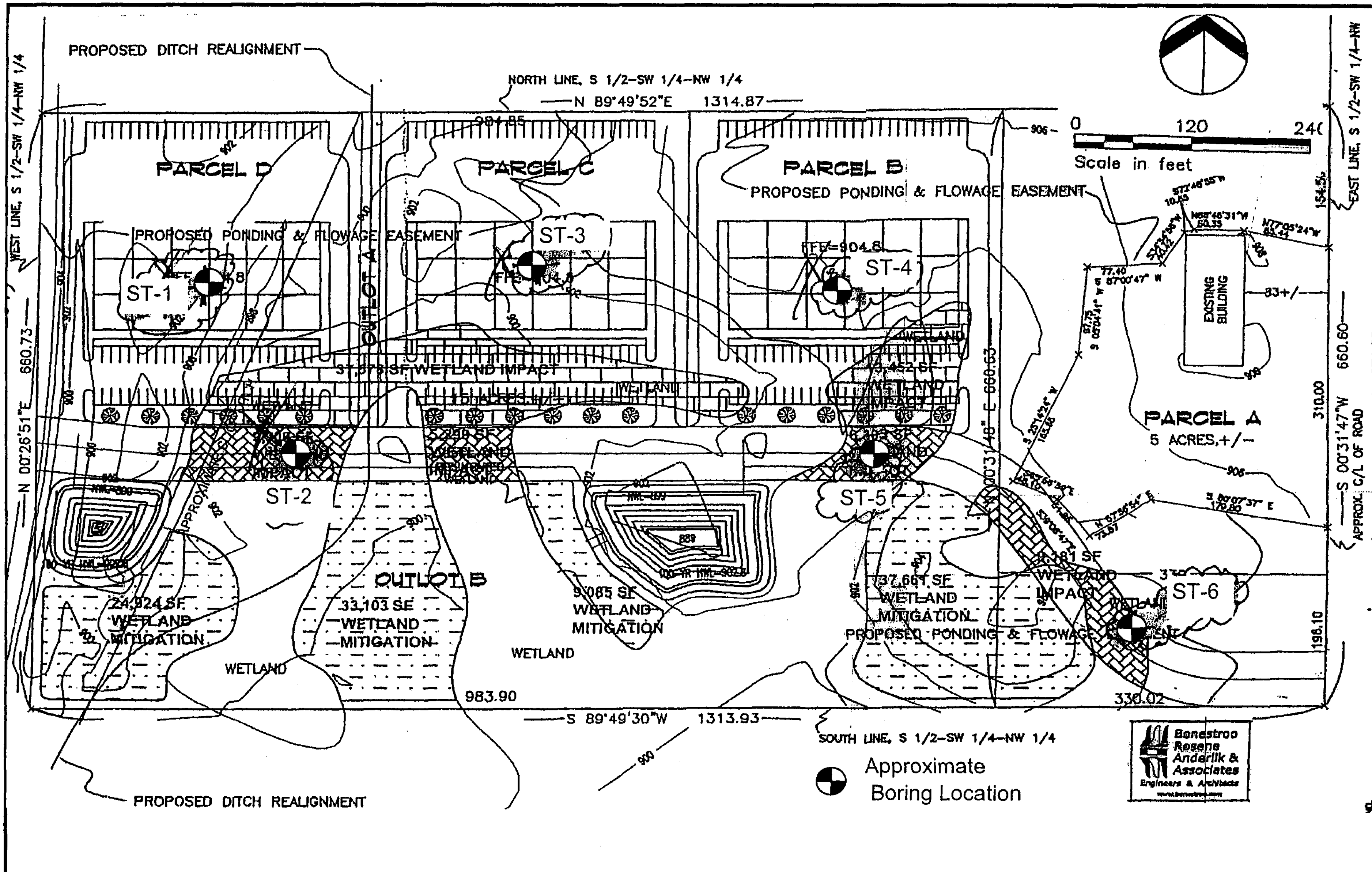
E.2.b. Construction Observations and Testing

It is recommended that we be retained to perform observations and tests during construction. This will allow correlation of the subsurface conditions encountered during construction with those encountered by the borings, and provide continuity of professional responsibility.

E.3. Standard of Care

This report is for the exclusive use of the parties to which it has been addressed. Without written approval, we assume no responsibility to other parties regarding this report. Our evaluation, analyses and recommendations may not be appropriate for other parties or projects.

In performing its services, Braun Intertec used that degree of care and skill ordinarily exercised under similar circumstances by reputable members of its profession currently practicing in the same locality. No warranty, express or implied, is made.



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DRAWN BY SDG	12/14/2005	1	GEOTECHNICAL EVALUATION CENTERVILLE INDUSTRIAL PARK CENTERVILLE MINNESOTA
APP'D BY		OF	
JOB NO. SP-05-05003		1	
DWG NO. SCALE NTS	FIGURE #	1	

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LOG OF BORING

Braun Project SP-05-05003 **Geotechnical Evaluation** **Industrial Park Improvements** **20th Avenue N, South of Main Street** **Centerville, Minnesota**	BORING: **ST-1** LOCATION: See attached sketch.

DRILLER: C. Powers	METHOD: 3 1/4" HSA, Autohmr	DATE: 11/11/05	SCALE: 1" = 4'

Elev. feet 902.0	Depth feet 0.0	ASTM Symbol	Description of Materials (ASTM D2488 or D2487)	BPF	WL	Tests or Notes
901.3	0.7	OL	ORGANIC CLAY, black, moist. (Topsoil)			
		CL	SANDY LEAN CLAY, gray with black, wet, medium to rather stiff. (Alluvium)	8		
				11		
896.0	6.0	CL	SANDY LEAN CLAY, gray, wet, rather soft. (Glacial Till)	5		
891.5	10.5			5		
			END OF BORING. Water not observed with 9 feet of hollow-stem auger in the ground. Water not observed to cave-in depth of 8 feet immediately after withdrawal of auger. Boring then backfilled.			

(See Descriptive Terminology sheet for explanation of abbreviations)

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LOG OF BORING

Braun Project SP-05-05003 Geotechnical Evaluation Industrial Park Improvements 20th Avenue N, South of Main Street Centerville, Minnesota	BORING: ST-2 LOCATION: See attached sketch.

DRILLER: C. Powers	METHOD: 3 1/4" HSA, Autohmr	DATE: 11/11/05	SCALE: 1" = 4'

Elev. feet 900.0	Depth feet 0.0	ASTM Symbol	Description of Materials (ASTM D2488 or D2487)	BPF	WL	MC %	Tests or Notes
		OL	ORGANIC CLAY, black, moist. (Topsoil)		∇	90	OC = 15%
897.5	2.5			8		144	LL = 105 PI = 26
		SP-SM	POORLY GRADED SAND with SILT, fine-grained, gray, wet, loose. (Glacial Outwash)				
				10			
893.0	7.0						
		CL	LEAN CLAY, with Poorly Graded Sand lenses, gray, wet, rather soft. (Glacial Till)	4			
				5			
889.5	10.5						
			END OF BORING. Water observed at 2 1/2 feet while drilling. Water down 7 feet with 9 feet of hollow-stem auger in the ground. Water down 1 foot at a cave-in depth of 5 feet. Boring then backfilled.				

(See Descriptive Terminology sheet for explanation of abbreviations)

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LOG OF BORING

Braun Project SP-05-05003
Geotechnical Evaluation
Industrial Park Improvements
20th Avenue N, South of Main Street
Centerville, Minnesota

BORING: **ST-3**

LOCATION: See attached sketch.

DRILLER: C. Powers | METHOD: 3 1/4" HSA, Autohmr | DATE: **11/11/05** | SCALE: **1" = 4'**

Elev. feet 902.0	Depth feet 0.0	ASTM Symbol	Description of Materials (ASTM D2488 or D2487)	BPF	WL	MC %	P200 %	Tests or Notes
901.5	0.5	OL	ORGANIC CLAY, black, moist. (Topsoil)			16		OC = 2%
		SM	SILTY SAND, fine-grained, brown to brown with gray, moist, loose. (Glacial Till)	7		28	41	
					▽			
896.0	6.0			6				
		CL	LEAN CLAY, gray, moist, rather soft. (Glacial Till)	4				
891.5	10.5			4				

END OF BORING.

Water observed at 4 feet while drilling.

Water not observed with 9 feet of hollow-stem auger in the ground.

Water not observed to cave-in depth of 3 feet immediately after withdrawal of auger.

Boring then backfilled.

(See Descriptive Terminology sheet for explanation of abbreviations)

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LOG OF BORING

Braun Project SP-05-05003 Geotechnical Evaluation Industrial Park Improvements 20th Avenue N, South of Main Street Centerville, Minnesota	BORING: ST-4 LOCATION: See attached sketch.

DRILLER: C. Powers	METHOD: 3 1/4" HSA, Autohmr	DATE: 11/11/05	SCALE: 1" = 4'

Elev. feet 904.0	Depth feet 0.0	ASTM Symbol	Description of Materials (ASTM D2488 or D2487)	BPF	WL	Tests or Notes
902.5	1.5	OL	ORGANIC CLAY, black, moist. (Topsoil)			
900.0	4.0	SC	CLAYEY SAND, fine-grained, light brown, moist, medium. (Alluvium)	8	∇	
896.0	8.0	CL	LEAN CLAY, brownish-gray, wet, rather soft. (Alluvium)	4 5		
893.5	10.5	CL	SANDY LEAN CLAY, with layer of Poorly Graded Sand, brownish-gray, wet, medium. (Alluvium)	6		
			END OF BORING. Water observed at 4 feet while drilling. Water down 8 feet with 9 feet of hollow-stem auger in the ground. Water not observed to cave-in depth of 6 feet immediately after withdrawal of auger. Boring then backfilled.			

(See Descriptive Terminology sheet for explanation of abbreviations)

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LOG OF BORING

Braun Project SP-05-05003 Geotechnical Evaluation Industrial Park Improvements 20th Avenue N, South of Main Street Centerville, Minnesota	BORING: ST-5 LOCATION: See attached sketch.
DRILLER: C. Powers	METHOD: 3 1/4" HSA, Autohmr	DATE: 11/11/05	SCALE: 1" = 4'

Elev. feet 902.0	Depth feet 0.0	ASTM Symbol	Description of Materials (ASTM D2488 or D2487)	BPF	WL	Tests or Notes
900.5	1.5	OL	ORGANIC CLAY, black, moist. (Topsoil)		▽	
898.0	4.0	SP-SM	POORLY GRADED SAND with SILT, fine-grained, brown, wet, loose. (Glacial Outwash)	5		
891.5	10.5	CL	SANDY LEAN CLAY, gray, wet, rather soft to medium. (Glacial Till)	4 5 7		
			END OF BORING. Water observed at 1 1/2 feet while drilling. Water not observed with 9 feet of hollow-stem auger in the ground. Water down 1 1/2 feet at a cave-in depth of 2 feet. Boring then backfilled.			

(See Descriptive Terminology sheet for explanation of abbreviations)

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LOG OF BORING

Braun Project SP-05-05003 **Geotechnical Evaluation** **Industrial Park Improvements** **20th Avenue N, South of Main Street** **Centerville, Minnesota**	BORING: **ST-6** LOCATION: See attached sketch.

DRILLER: C. Powers	METHOD: 3 1/4" HSA, Autohmr	DATE: **11/11/05**	SCALE: **1" = 4'**

Elev. feet 904.0	Depth feet 0.0	ASTM Symbol	Description of Materials (ASTM D2488 or D2487)	BPF	WL	Tests or Notes
902.5	1.5	OL	ORGANIC CLAY, black, moist. (Topsoil)			
900.0	4.0	CL	LEAN CLAY, brown, moist, rather soft. (Alluvium)	5		
897.0	7.0	SP-SM	POORLY GRADED SAND with SILT, fine- to medium-grained, brown, moist, loose. (Glacial Outwash)	7	∇	
893.5	10.5	CL	SANDY LEAN CLAY, gray, moist, medium, rather stiff. (Glacial Till)	7 9		
			END OF BORING. Water not observed with 9 feet of hollow-stem auger in the ground. Water down 5 feet at a cave-in depth of 5 feet. Boring then backfilled.			

(See Descriptive Terminology sheet for explanation of abbreviations)

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Descriptive Terminology

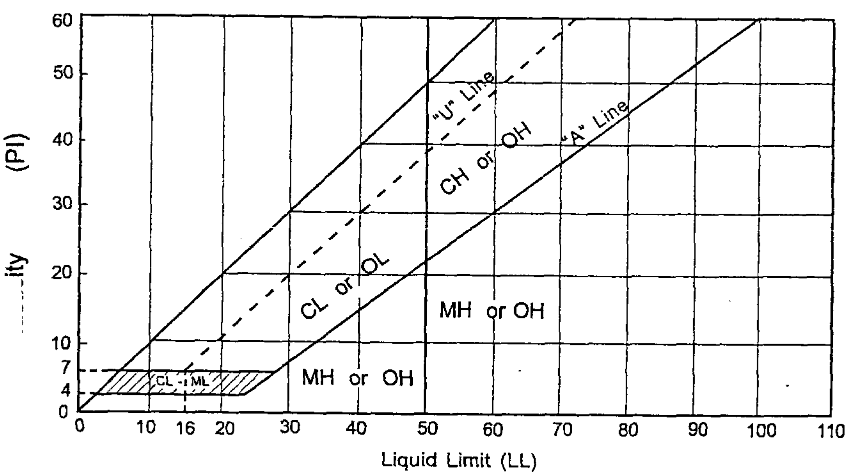
Rev. 10/04

ASTM INTERNATIONAL

Standard D 2487 - 00
Classification of Soils for Engineering Purposes
(Unified Soil Classification System)

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests [a]				Soils Classification	
				Group Symbol	Group Name [b]
Coar[illegible]ed [illegible] more than 50% retained on No. 200 sieve	Gravels More than 50% of coarse fraction retained on No. 4 sieve	Clean Gravels Less than 5% fines [e]	$C_u \geq 4$ and $1 \leq C_c \leq 3$ [c]	GW	Well-graded gravel [d]
			$C_u < 4$ and/or $1 > C_c > 3$ [c]	GP	Poorly graded gravel [d]
		Gravels with Fines More than 12% fines [e]	Fines classify as ML or MH	GM	Silty gravel [d f g]
			Fines classify as CL or CH	GC	Clayey gravel [d f g]
	Sands 50% or more of coarse fraction passes No. 4 sieve	Clean Sands Less than 5% fines [i]	$C_u \geq 6$ and $1 \leq C_c \leq 3$ [c]	SW	Well-graded sand [h]
			$C_u < 6$ and/or $1 > C_c > 3$ [c]	SP	Poorly graded sand [h]
		Sands with Fines More than 12% [i]	Fines classify as ML or MH	SM	Silty sand [f g h]
			Fines classify as CL or CH	SC	Clayey sand [f g h]
Fine-[illegible] Soil[illegible] 50% or more passed the No. 200 sieve	Silts and Clays Liquid limit less than 50	Inorganic	PI > 7 and plots on or above "A" line [j]	CL	Lean clay [k l m]
			PI < 4 or plots below "A" line [j]	ML	Silt [k l m]
		Organic	$\frac{\text{Liquid limit - oven dried}}{\text{Liquid limit - not dried}} < 0.75$	OL	Organic clay [k l m n]
				OL	Organic silt [k l m o]
	Silts and clays Liquid limit 50 or more	Inorganic	PI plots on or above "A" line	CH	Fat clay [k l m]
			PI plots below "A" line	MH	Elastic silt [k l m]
		Organic	$\frac{\text{Liquid limit - oven dried}}{\text{Liquid limit - not dried}} < 0.75$	OH	Organic clay [k l m p]
				OH	Organic silt [k l m q]
Highly Organic Soils		Primarily organic matter, dark in color and organic odor		PT	Peat

a. Based on the material passing the 3-in (75mm) sieve.
b. If field sample contained cobbles or boulders, or both, add "with cobbles or boulders or both" to group name.
c. $C_u = D_{60} / D_{10}$ $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$
d. If soil contains ≥15% sand, add "with sand" to group name.
e. Gravels with 5 to 12% fines require dual symbols:
GW-GM well-graded gravel with silt
GW-GC well-graded gravel with clay
GP-GM poorly graded gravel with silt
GP-GC poorly graded gravel with clay
f. If fines classify as CL-ML, use dual symbol GC-GM or SC-SM.
g. If fines are organic, add "with organic fines" to group name.
h. If soil contains ≥15% gravel, add "with gravel" to group name.
i. Sands with 5 to 12% fines require dual symbols:
SW-SM well-graded sand with silt
SW-SC well-graded sand with clay
SP-SM poorly graded sand with silt
SP-SC poorly graded sand with clay
j. If Atterberg limits plot in hatched area, soil is a CL-ML, silty clay.
k. If soil contains 15 to 29% plus No. 200, add "with sand" or "with gravel" whichever is predominant.
l. If soil contains ≥ 30% plus No. 200, predominantly sand, add "sandy" to group name.
m. If soil contains ≥ 30% plus No. 200 predominantly gravel, add "gravelly" to group name.
n. PI ≥ 4 and plots on or above "A" line.
o. PI < 4 or plots below "A" line.
p. PI plots on or above "A" line.
q. PI plots below "A" line.



Laboratory Tests

[illegible]	Dry density, pcf	OC	Organic content, %
[illegible]	Wet density, pcf	S	Percent of saturation, %
[illegible]	Natural moisture content, %	SG	Specific gravity
[illegible]L	Liquid limit, %	C	Cohesion, psf
[illegible]	Plastic limit, %	∅	Angle of internal friction
	Plasticity index, %	qu	Unconfined compressive strength, psf
[illegible]000	% passing 200 sieve	qp	Pocket penetrometer strength, tsf

Particle Size Identification

Boulders .... over 12"
Cobbles .... 3" to 12"
Gravel
Coarse .... 3/4" to 3"
Fine .... No. 4 to 3/4"
Sand
Coarse .... No. 4 to No. 10
Medium .... No. 10 to No. 40
Fine .... No. 40 to No. 200
Silt .... < No. 200, PI < 4 or below "A" line
Clay .... < No. 200, PI ≥ 4 and on or above "A" line

Relative Density of Cohesionless Soils

Very loose .... 0 to 4 BPF
Loose .... 5 to 10 BPF
Medium dense .... 11 to 30 BPF
Dense .... 31 to 50 BPF
Very dense .... over 50 BPF

Consistency of Cohesive Soils

Very soft .... 0 to 1 BPF
Soft .... 2 to 3 BPF
Rather soft .... 4 to 5 BPF
Medium .... 6 to 8 BPF
Rather stiff .... 9 to 12 BPF
Stiff .... 13 to 16 BPF
Very stiff .... 17 to 30 BPF
Hard .... over 30 BPF

Drilling Notes

Standard penetration test borings were advanced by 3[illegible]" or 6[illegible]" ID hollow-stem augers unless noted otherwise. Jetting water was used to clean out auger prior to sampling only where indicated on logs. Standard penetration test borings are designated by the prefix "ST" (Split Tube). All samples were taken with the standard 2" OD split-tube sampler, except where noted.

Power auger borings were advanced by 4" or 6" diameter continuous-flight, solid-stem augers. Soil classifications and strata depths were inferred from disturbed samples augered to the surface and are, therefore, somewhat approximate. Power auger borings are designated by the prefix "B."

Hand auger borings were advanced manually with a 1[illegible]" or 3[illegible]" diameter auger and were limited to the depth from which the auger could be manually withdrawn. Hand auger borings are indicated by the prefix "H."

BPF: Numbers indicate blows per foot recorded in standard penetration test, also known as "N" value. The sampler was set 6" into undisturbed soil below the hollow-stem auger. Driving resistances were then counted for second and third 6" increments and added to get BPF. Where they differed significantly, they are reported in the following form: 2/12 for the second and third 6" increments, respectively.

WH: WH indicates the sampler penetrated soil under weight of hammer and rods alone; driving not required.

WR: WR indicates the sampler penetrated soil under weight of rods alone; hammer weight and driving not required.

TW indicates thin-walled (undisturbed) tube sample.

Note: All tests were run in general accordance with applicable ASTM standards.

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